Curvus Pro

version 3.1

User's Guide

© September 2000 Arizona
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Introduction

Presentation

Curvus Pro has been developed in order to provide a quick user-friendly and powerful tool for graphing any kind of two- and three-dimensional algebraic relation such as:

- Any explicit, implicit or parametric curve and graph
- 2D and 3D vector fields
- 2D and 3D scalar (density) fields
- Solutions of differential equations up to the third order
- 2D logical relations

The interface aims to be as transparent and easy to use as possible so that any user can rapidly and naturally take advantage of the many options provided by Curvus Pro.

The intuitive equation editor that offers an ideal way of entering mathematical expressions, is just one out of the numerous original features included in Curvus Pro.

Also, several visualization options are available, such as:

- Several curves or graphs on the same document
- Variable parameters for curve family plots corresponding to the different values of the parameter
- Many vector drawing options, etc.

Several numerical evaluation options allow calculating:

- Coordinates, derivatives, tangents, osculating circles at any point of a curve, a graph or a field
- Roots, extrema and inflexion point as well as intersections of 2D curves
- Integrals over a finite or infinite range.

Numerous dynamic options (animations, QuickTime movies, QuickDraw™ 3D) provide a powerful way of visualizing the evolution of these objects as function of some parameters.

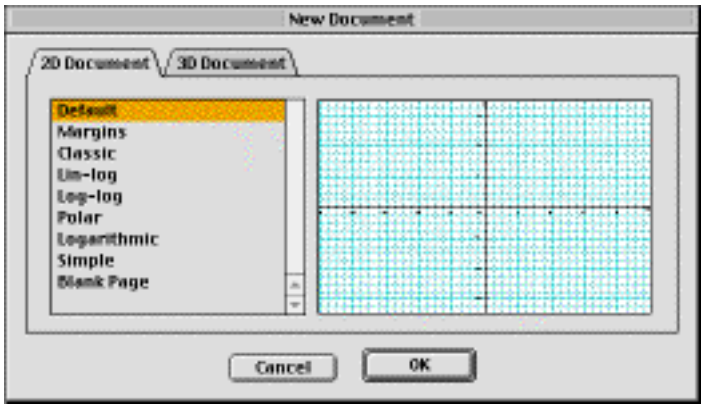
Eventually, different exporting options are provided:

- High quality printing
- High definition picture exporting, including PostScript format, etc.

Getting Used in a Few Seconds

Creating a New Document

After starting the application, or after selecting **New** under the **File** menu, following dialog shows up:



Select the desired document type by clicking on the corresponding tab. Chose then a layout from the list and confirm the dialog.

2D Document

- Note

  The meaning of the word "curve" is here quite general: it includes any element of a 2D document described by one or several algebraic relations, such as ordinary curves, vector fields, scalar fields and logic relations.

Creating a New Curve

Select **New** under the **Curve** menu. In the appearing dialog, chose the desired curve type and confirm the dialog.

- Note

  The different coordinate types are described in the chapter **Coordinates** on page 10.

  Enter then the expression(s) describing the new curve in the dialog that shows up and confirm.

Manipulating Curves

To select a curve, just:

- Click on the curve in the document window, with the Shift key down for a multiple selection*

or

- Select the corresponding item under the **Curve** menu.

Selected curves are marked with a "√" in the **Curve** menu and are highlighted in the document window.

To modify the expression of a curve, just:

- Double-click on it in the document

or

- Select **Modify** under the **Curve** menu after the curve has been selected.

To modify the line attributes of a curve (color, pattern, width), use the following icons of the **Tool** toolbar:

To delete the selected curve(s), use the **Backspace** key.

To duplicated the selected curve(s), chose **Duplicate** under the **Edit**.

Modifying the Window Range

Zooming In or Out

To zoom in or out, chose the corresponding item under the **Options** menu (or click on the icons and of the **Options** toolbar). Click then on the point of the document window to zoom at.

You can also use the icons situated in the bottom left corner of the document window.

Expanding a Rectangular Region

To expand a rectangular region of the window range chose **Expand** under the **Options** menu (or click on the icon of the **Options** toolbar). Drag* then the desired box to be expanded in the document window.

* Is not valid for vector fields, scalar fields and logic relations

Adjusting the Window Range

To adjust the window range means to change its values so that all the curves fit on the visible part of the window. To do so, chose **Adjust** under the **Options** menu or click on the icon of the **Options** toolbar.

This option can be quite useful when some curve exceeds the current window range and is so not or only partially visible.

Other Items of the Options Menu

To shift the window range, select **Shift** and drag the axis origin.

To center the axis origin to the middle of the window chose **Center Axis**.

To make the basis orthonormal (i. e. same scale for both axis), chose **Make Basis Orthonormal**.

To modify the tick-mark spacing (and so the range of the corresponding axis), chose **Extend Tick-Marks**, click on a tick-mark and drag it.

Modifying Window Range Values

Chose **Document** under the **Format** menu and click on the **Domain** tab. You can then enter the different minimal and maximal values for the window range, select the scales (linear or logarithmic) as well as the reference frame (1 unit = 1 cm on one axis, e.g.). Select the **Orthonormal Basis** checkbox to keep the document basis orthonormal when modifying the window range.

You can also double-click on one axis and select the **Range** tab to modify the values of the corresponding axis range.

You can also enter directly the different values in the **Window Ran**ge toolbar (chose the corresponding item under the **Window** menu if hidden).

Copying into the Clipboard

To copy the whole picture of the document window into the Clipboard, chose **Copy** from the **Edit** menu (no curve must be selected).

To copy only a part of the window, chose **Snapshot** under the **Special** menu or click on the icon of the **Options** toolbar. Drag then the desired box in the document window.

To copy a picture containing only some curves, select the curves to be included in the picture and chose **Copy** under the **Edit** menu (see chapter **The Preferences Dialog** on page 47).

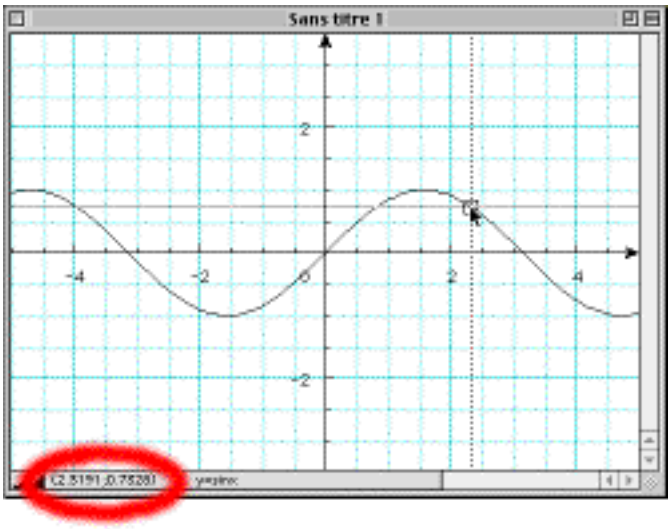
♦ Note

To copy a high definition picture, keep the Shift key down while choosing **Copy** under the **Edit**.

* Click and grow box while keeping the mouse button.

Numerical Calculation

To calculate the coordinates of a point from a curve shown in the window, just move the mouse cursor over it: a haircross appears which coordinates are shown at the bottom of the document window.



To evaluate different values at a point of a curve (coordinates, derivatives, tangents, etc.), to find a root or an intersection of cartesian curves, or to calculate an integral, select the items **Evaluation**, **Root Find**, **Intersection Find** or **Integration** under the **Options** menu. You can also click on the icons , , or of the **Options** toolbar.

For further information, see chapter **Numerical Evaluations** on page 27.

3D Document

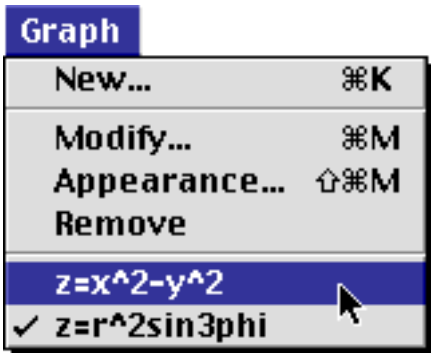
Creating a New Graph

Select **New** under the **Graph** menu. In the dialog showing up, select the type of graph you want to create and confirm.

Enter then the expression(s) describing the new graph in the next dialog appearing.

Manipulating Graphs

The default selection is the most recently created graph.



To select some other graph, select the corresponding item under the **Graph** menu. The selected graph is marked with a "√" in the menu.

To change the expression of the selected graph, chose **Modify**.

To modify the appearance of the selected graph, chose **Appearance**.

To delete the selected graph, chose **Remove**.

Modifying the Graph Range

Zooming

To perform a zoom:

- Chose Zoom In or Zoom Out under the Options menu
- Click on the icons and of the **Options** toolbar
- Click on the icons in the bottom left corner of the document window.

Adjusting the Graph Range

To adjust the range to the plotted graphs chose **Adjust** from the **Options** menu or click on the icon of the **Options** toolbar.

Shifting the Horizontal Range

To shift the horizontal range (i. e. along x- and y-axis), chose **Horizontal Offset** under the **Options** menu (on click on the icon of the **Options** toolbar). Click then on the graph and drag the horizontal range while keeping the mouse button down.

Modifying the Values of the Graph Range

To modify the minimal and maximal values of the graph range, chose **Graph** under the **Format** menu (or double-click on the graph in the document window). Click on the **Domain** tab. You can then change the different values and scales (linear or logarithmic).

You can also enter directly these values in the **Window Range** toolbar (chose corresponding item under **Window** menu to show it).

Miscellaneous Items of the Options Menu

To center the axis origin, chose **Center Axis**.

To make the basis orthonormal, chose the corresponding item.

Numerical Calculation

To evaluate different values at a point a of graph (coordinates, derivatives, etc.) or to integrate a function, chose Evaluation or Integration under the Options menu (or click on the icon of the Options toolbar).

For further information, see chapter **Numerical Evaluations** on page 27.

QuickDraw™ 3D

When running Curvus Pro on a Power Macintosh with the QuickDraw™ 3D extension enabled, the QuickDraw™ 3D mode can be activated by chosing the corresponding item under the **QuickDraw** menu.

This mode allows the user to manipulate the graph in real time or to navigate around it by moving the viewpoint. For further information, see chapter **Navigation** on page 32.

Entering an Expression

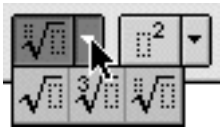
The Equation Editor

Curvus Pro provides a user-friendly equation editor, ideal for entering and manipulating mathematical expressions. Its ease of use allows any user to rapidly get advantage of it.

The Equation Editor Toolbar

To insert special characters or different symbols, use the toolbar appearing at the top of the screen, just under the menu bar:

Click on a button to insert the corresponding character or symbol. Click on an arrow to pull down a pop-up menu proposing other symbols.



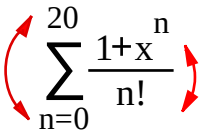
The most recently used symbol is shown in the corresponding button.

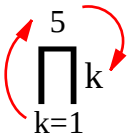
♦ Note

See chapter **The Preferences Dialog** on page 48 to activate or deactivate the equation editor, and to select the default police.

Moving the Cursor

Use the **arrow keys** to move the cursor in a field, as well as reaching numerator or denominator of a fraction, limits of a sum, product or integral.





To expand the selection, keep the **Shift key** down. To move to the next term, keep the **Option key** down.

Use the **Tab key** (with **Shift key** down) to move to the next (previous) field of a fraction, sum, integral, etc.

Brackets, roots and fractions

To put some text in brackets or into the numerator of a fraction, make it the selection and type « (» resp. « / ».

To remove a symbol such as a root, a fraction, a sum, etc. place the cursor at the left of the main field (denominator for fraction) and type **Backspace**.

$$\sqrt[3]{1+x} \qquad \frac{1}{x}$$

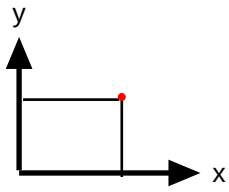
Drag & Drop

If the **Drag & Drop** extension is available on your system, you can easily move the selection (or copy it when **Option** key is down) by dragging it with the mouse cursor.

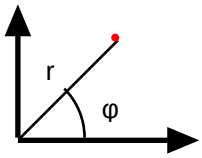
Coordinates

Coordinates in the Plane

Curvus Pro uses two kind of planar coordinates:



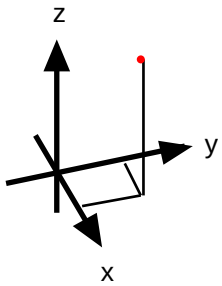
Cartesian



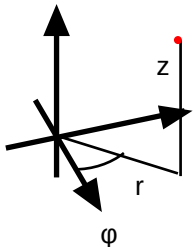
Polar

Coordinates in the Space

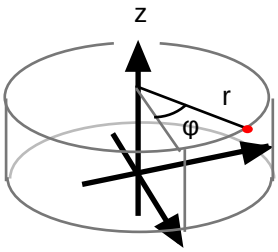
Curvus Pro uses four kind of spatial coordinates:



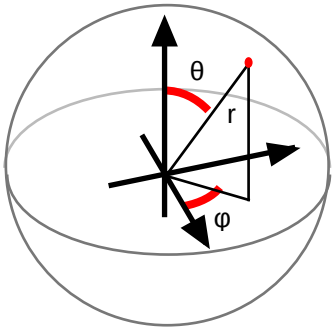
Cartesian



Polar



Cylindrical



Spherical

Operators

Scalar Operators

Here is a list of the recognized scalar operators, listed by priority:

Priority 1:	^	(power)
Priority 2:	* •	(multiplication)
	/ ÷	(division)
	\	(modulo)
Priority 3:	+ –	(addition, subtraction)

♦ Note

Curvus Pro provides a particularly simple syntax to define a function by parts. See chapter **Expression Defined by Parts** on page 17.

Boolean Operators

Here is a list of the recognized boolean operators, listed by priority:

Priority 1:	>	(strictly greater)
	<	(strictly lower)
	≥ >= =>	(greater or equal)
	≤ <= =<	(lower or equal)
	=	(equal)
	≠ <> !=	(different)
Priority 2:	¬ NOT NON	(logical *no*)
Priority 3:	AND ET &	(logical *and*)
Priority 4:	OR OU	(logical *or*)
	XOR EOU	(exclusive *or*)
	IN DANS	(inside interval)

Interval Operators

The recognized interval operators are the following:

Priority 1:	¬ NOT NON ~	(complement)
Priority 2:	∩ *	(intersection)
Priority 3:	+	(union)
	–	(difference)

A interval is defined with square brackets:

Examples:	[a;b]	(closed interval)
	]a;b[	(open interval)
	[a;b[	(semi-closed interval)

Special Operators

Sum: “∑”, “Somme” or “Sum”
The syntax is the following:

$$\sum_{var=min}^{max} f(var)$$

or, without equation editor: ∑(var=min..max;f(var))
Example:

$$\sum_{n=1}^{10} f(n) = f(1)+f(2)+\ldots+f(10)$$

Product: “∏” or “Prod”
The syntax is the same as for the sum. Example:

$$\prod_{k=1}^{5} \frac{n^k}{k!} = \frac{n^1}{1!}\cdot\frac{n^2}{2!}\cdot\ \cdots\ \cdot\frac{n^5}{5!}$$

or, without equation editor: ∏ (k=1..5;n^k/k!)

Integral: “∫” or “Integr”
The syntax is the following:

$$\int_{t=a}^{b} f(t)$$

or, without equation editor: Integr(t=a..b;f(t))
Example:

$$\frac{2}{\sqrt{\pi}}\int_{t=0}^{x} e^{-t^2} = \mathrm{erf}(x)$$

Derivative: “ ' ”, “ ’ ” or “ ∂ ”
Syntax:

$$f' \text{ or } f\partial n = f\overbrace{\cdots}^{n\ \text{times}}$$

Examples:

$$f'(a)=\frac{\partial}{\partial x}f(x)\Big|_{x=a}$$

sin''(π)=-sin(π)

f∂3(x)=f'''(x)

- Note:

$f'(g(x)) = \frac{\partial f}{\partial x}(g(x)) \neq \frac{\partial f}{\partial x}(g(x))\ \frac{\partial g}{\partial x}(x)$. So, exp'(ax)=exp(ax) and not exp(ax)a !

Iteration: " @ "
Syntax:

$$f@n(x) = \overbrace{f(f(...f}^{\text{n times}}(x)))$$

Convolution: " # "
Syntax:

f#g

Example:

$$f\#g(x) = \int_{-\infty}^{\infty} f(t)\cdot g(x-t)\,dt$$

Comments: " ' "
Syntax:

…"my comments"…

Recognized Words

Recognized Constants

The following constants are recognized by Curvus Pro (in MKSA units):

π	=	3.141592653589…	
e	=	2.718281828459…	(Euler number)
cLight	=	2.99792458 e8	(speed of light in vacuum)
e0	=	8.85418782 e-12	(permitivity of vacuum)

F	=	9.648456 e4	(Faraday constant)
G	=	6.6732 e-11	(Gravitational constant)
gamma	=	0.5772157	
h	=	6.6262 e-34	(Planck constant)
kBoltz	=	1.3807 e-23	(Boltzmann constant)
Na	=	6.022 e23	(Avogadro's number)
R	=	8.3144	(gas constant)
U	=	1.6605655 e-27	(atomic mass)
μ0	=	4π e-7	(permeability of vacuum)

For complex numbers:

i = j = $\sqrt{-1}$

And the logical constants:

true , vrai	=	Boolean *yes*	(result of 0=0)
false , faux	=	Boolean *no*	(result of 0=1)
nil , nan	=	*not a number*	(result of ln(0), 1÷0, etc.)

Recognized Variables

The following variables are recognized by Curvus Pro:

x, y, z, r, φ, θ	coordinates (see chapter on page 10)
t, u	parameters for parametric curves
v	speed (=$\|\dot{\mathbf{r}}\|$ for differential equations)

♦ Note

Constant and variables names are case sensitive: "r" and "R" are names of two different constants.

Recognized Functions

The following functions are available in Curvus Pro:

Trigonometric

sin	cos	tan
cot, ctn	sec	csc
asin, arcsin	acos, arccos	atan, arctan

acot, arccot, actn, arcctn

deg (value in degrees of the angle as parameter)

rad (value in radians…)

grad (value in grades…)

hypot (hypot(a;b)=sqrt(a^2+b^2))

atan2 (atan2(y;x) returns the arctangent of y/x in [-π,π], according to the signs of x and y)

Hyperbolic

sinh	cosh	tanh	coth
asinh, arcsinh, argsinh	acosh, arccosh, argcosh		
atanh, arctanh, argtanh	acoth, arccoth, argcoth		

Bessel

I(n;x)	J(n;x)	K(n;x)
Y(n;x)		

Complex Numbers

cis (cisß=cosß+isinß)	re (real part)	im (imaginary part)
arg (argument in [-π,π])		

Miscellaneous

abs	exp	fgamma	
fpart (fractional part)			
int, ipart (integer part)	inv (inverse)		
log (basis 10)	ln (natural)		sq (square)
nsqrt(n;x) (n-th root of x)		sqrt, sqr (square root)	
sgn (sign)	fact (factorial)		
rnd (random number, 0≤rnd<1)			
min(a;b;c;…) (lower value)			
max(a;b;c;…) (greater value)			
erf()	erfc()	lgamma()	
gammaP()	gammaQ()		beta()

Rounding

int(),floor()	greatest integer number lower or equal
ceil()	smallest integer number greater or
trunc()	closest integer number starting from zero
round()	rounded (round(x)=int(x+0.5))

♦ Note

Various syntaxes are recognized for some functions:

abs(x)=|x|	sqrt(x)=sqr(x)=√x	fact(x)=x!

- Note

  Function name are not case sensitive: "sin()" and "SIN()" are two names of the same function.

Syntax

The syntax of Curvus Pro is the traditional algebraic syntax.

Moreover, Curvus Pro also manipulates complex numbers (w=x+iy or w=x+jy). The part or the result to be considered (real part, imaginary part, modulus or argument) can be selected in the pop-up menus of the curve definition dialogs (see chapter **Graph Definition Dialogs** on page 43).

Simplifications

The multiplication sign may be omitted if implicit.

Examples: 2x=2*x $\pi r^2=\pi*r^2$
$a^2x=a^2*x$ [$=(a^2)*x$]
(x-2)(x+1)=(x-2)*(x+1)

If a function has only one parameter and if this one does not contain any operator (except exponent), the brackets can be omitted.

Examples: sinx=sin(x) log2x=log(2x)
$\cos x^2=\cos(x^2)$ $\tan 2x^2=\tan(2x^2)$
lnabsx=ln(abs(x))=ln|x|

but sqrt2*x=sqrt(2)*x lna+b=ln(a)+b
sin(x)sin(y)=sinx*siny ≠ sinxsiny=sin(xsiny)

If a function is taken to a power, following syntax may be used:

$f^mx=(f(x))^m$

Example: $\sin^2(x)=(\sin x)^2=\sin^2 x$

but $\sin x^2=\sin(x^2)$

Expression Defined by Parts

To define a expression by parts, Curvus Pro offers various syntaxes:

« condition1: expression1 [; condition2:expression2; etc.] »

or

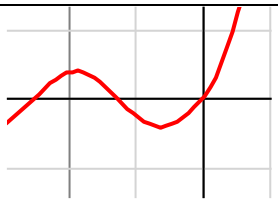
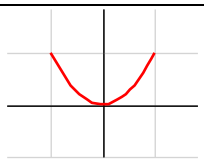
« expression1, condition1 [,expression2, condition2, etc.] »

or

« expression, condition; other expression »

You just have to separate condition and expression « : », « , », « ; » or by **Return**.

See following examples:

« sinx, x<0; x(x+1), x>0 » *or* « x<0: sinx; x>0: x(x+1) » *or* « x<0: sinx, x(x+1) » *or* « sinx, x<0; x(x+1) »	
« |x|<1: x^2 » *or* « x^2, x]-1,1[»	

The conditions are Boolean conditions. The Boolean operators are mentioned in the chapter **Boolean Operators** on page 11.

Examples: |x|<1
sinx<cosx
x>=0 & x<=2 *equiv. to:* x [0,2] *or* x≥0 x≤2
x [a,b]∩[0,2] *equiv. to:* x [a,b] x [0,2]

Curvus Pro also treats conditional expressions. The syntax is the following:

IF condition1 **THEN** expression1 **ELSE** expression2

or

IF condition1 **THEN** expression1
ELSEIF condition2 **THEN** expression2
[**ELSEIF** condition n-1 **THEN** expression n-1…]
ELSE expression n

Example: IF x≤0 THEN 0 ELSE exp(-1/x^2)

Using Parameters and Custom Definitions

Variable Parameters

The user can define variable parameters in Curvus Pro, which are helpful to draw a function for different values of this parameter.

For example, you can plot the function x^3+kx^2-1 for k=1, 1.2, 1.4, … et 2.

In order to define them, there are two possibilities:

- Use the **Parameters** toolbar (see chapter **Parameters Toolbar** on page 40)
- In a dialog of curve definition, select **Parameters** (after having clicked on the first green triangle), click on the **New**… button. (see chapter **Graph Definition Dialogs** on page 43)

Once the parameter is defined, you can create any graph with an expression containing the name of it.

Example:

- Define variable “n” which vary between 1 and 3 in 5 steps of 0.5.
- Create then a curve of equation “sin(nx)”.
- Five curves are plotted, for the values 1, 1.5, 2, 2.5 and 3 of “n”.

♦ Note

An expression cannot make reference to more than one parameter at a time.

Custom Definitions

In Curvus Pro, you can define your own constants or functions, You have two possibilities for creating your own definitions:

- Use the **Custom Definition** toolbar (see chapter **Custom Definitions Toolbar** on page 41)
- In a dialog of curve definition, select **Custom Definitions** (after having clicked on the first green triangle), click on the **New**… button (see chapter **Graph Definition Dialogs** on page 43)

You only need to enter the expression of the constant or function in one of the following forms:

Constant: «name=expression»

Examples: diameter=2.4
perimeter=π*diameter
phi=(√5+1)/2

Function: «nam(parameters)=expression»

Examples: area(radius)=π*radius mean(p,q)=(p+q)/2

♦ Note

Custom definitions may have references to others.

Plug-Ins

Curvus Pro let you create your own plug-ins. A plug-in is a compiled routine, which defines a function that cannot be expressed algebraically.

Example: The plug-in "Mandelbrot" returns the maximum iteration number so that $|z_n| < 2$, the iteration being defined by

$$z_n = z_{n-1}^2 + c, \quad c = a + ib, \quad z_0 = 0$$

See the file "How to create your own plug-ins" for further information on this subject.

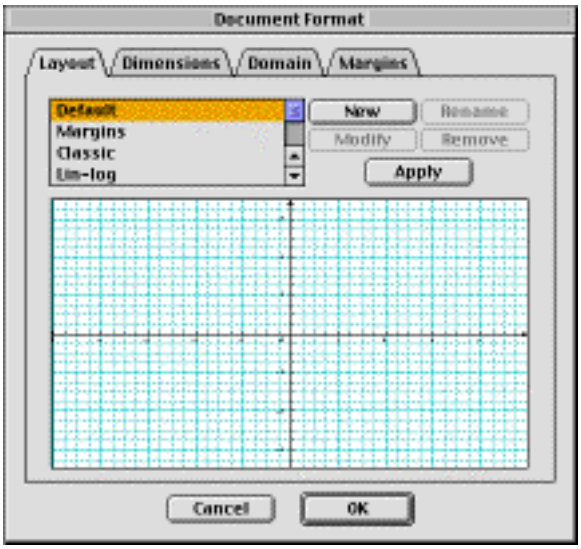
- Note

  Plug-ins (easily spotted by their icon) must be placed in the folder "Plug-Ins" located next to the application.

Laying Out a Document

Document Format

To change format and dimensions of your document chose **Document** under the **Format** menu. Following dialog appears:



Layouts

A document layout contains several parameters of the different formats of axis and grid (for 2D documents) or of the graph (for 3D documents). Many layouts are available when creating a new document (see chapter **Creating a New Document** on page 3).

To create a new layout from the current document, click on **New**. You can apply the selected layout to the current document by clicking on **Apply**. To change an existing layout according to the current document, click on **Modify**. Eventually, you can rename or erase a layout by clicking on **Rename** or **Erase**.

Dimensions

Click on the **Dimensions** tab of the **Document Format** dialog to modify the document dimensions. Several predefined formats are available in the pop-up menu.

♦ Note

You can also change directly the size of the document by clicking in the **Size corner** (bottom right) of the document window and keeping either the **Option** key or the **Command** key down.

Adding Drawing Objects

You can add several types of drawing objects (texts, circles, rectangles, lines, marks, equations, etc.) to a Curvus Pro document in order to illustrate it by some drawings or explanations.

These objects can be selected, moved and deleted as in any other common application: with the mouse, keeping the **Shift key** down for a multiple selection, typing **Backspace** to deleted the selected objects.

♦ Note

You may use the **Arrow keys** to adjust the position of some objects.

Tools Toolbar

You can use the **Tools** toolbar to add some vector drawing objects. These are more or less the same as the one encountered in any other vector drawing application.

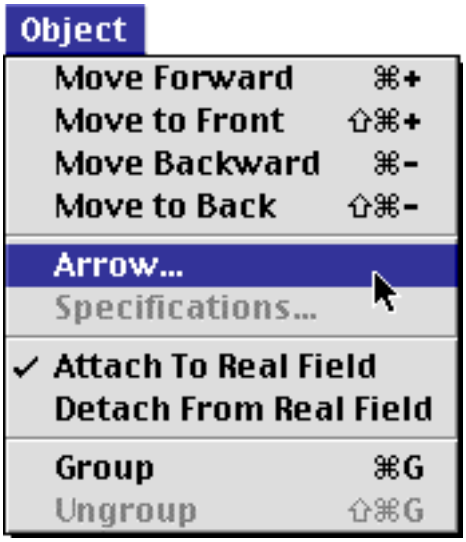
Click on one icon of the toolbar to select the corresponding object and click somewhere in the document window to insert it.

♦ Note

To keep an object selected in the toolbar, double-click on its icon.

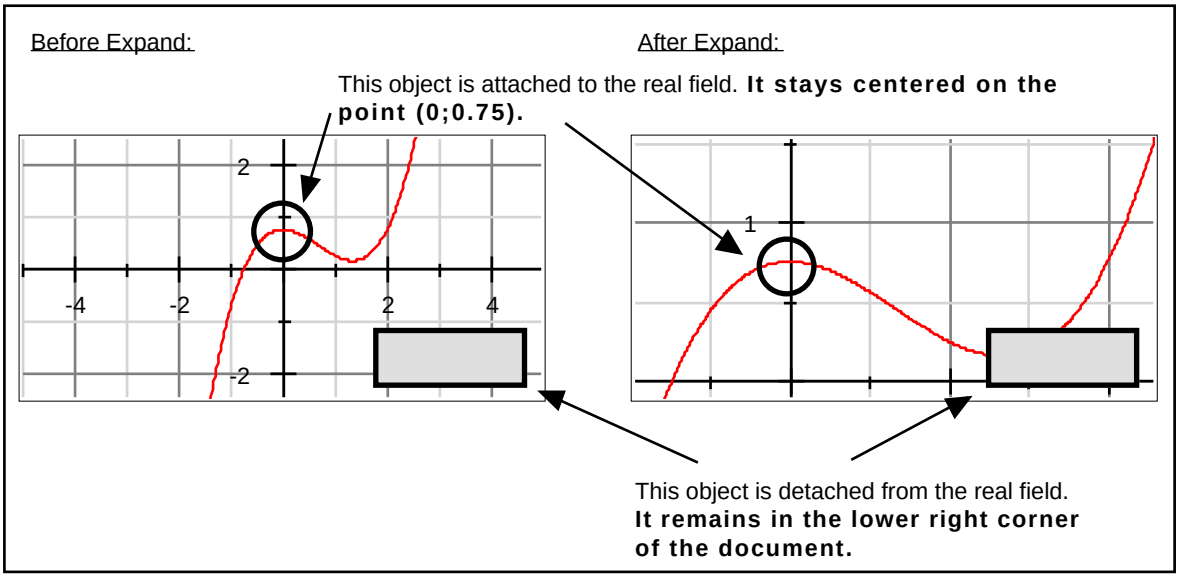
The Object Menu

Use the items **Move Forward**, **Move Backward**, **Move to Front** and **Move to Back** under the **Object** menu to modify the piling order of the selected objects.



Chose the items **Arrow** and **Specifications** to modify the appearance of the selected object.

Use the items **Attach to Real Field** and **Detach From Real Field** to attach or detach the selected objects to or from the real field. See the illustration under to understand the difference between an object attached and detached from the real field.


Before Expand:
After Expand:
This object is attached to the real field. It stays centered on the point (0;0.75).
2
-4
-2
2
4
-2
1
This object is detached from the real field. It remains in the lower right corner of the document.

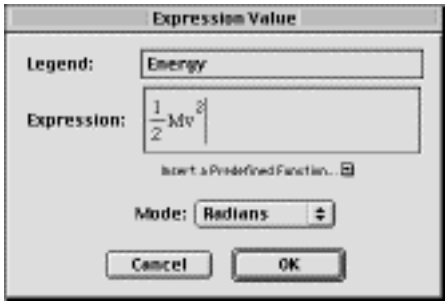
Difference between an object attached and detached from the real field.

Use the items **Group** and **Ungroup** to group and ungroup the selected objects.

The Special Menu (2D Document)

In a 2D document, you can add horizontal or vertical lines by choosing the corresponding items under the **Special** menu and by click on the desired point of the document window. To modify the position of an existing line, either double-click on it or just drag it.

To insert a text zone containing the value of an algebraic expression (updated continuously), chose **Insert Expression Value** and click on the desired point of the document window. In the dialog that shows up, you can enter the legend and the expression.



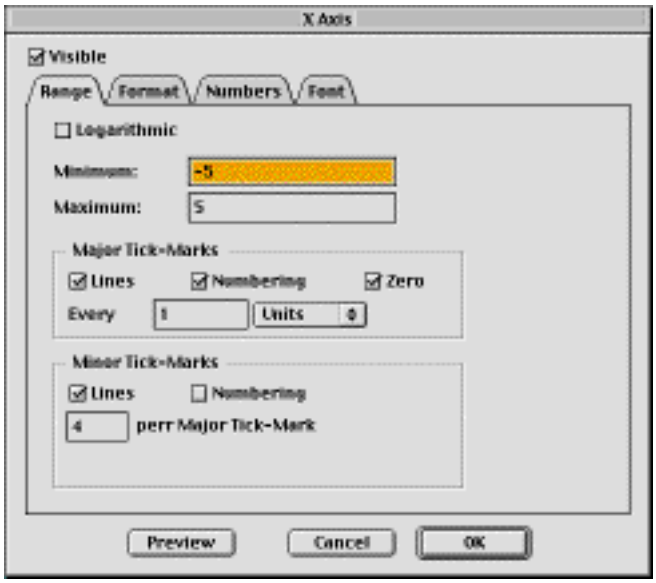
- Note

  The expression may contain any custom definitions.

Modifying Axis and Grid Appearance in a 2D Document

Modifying the Axis

To modify the axis of the current document, chose **X-Axis** or **Y-Axis** under the **Format** menu, or just double-click on one axis in the document window. Following dialog appears then:



Click on the **Range** tab to change the range value, the scale (linear or logarithmic) and the tick-marks.

Click on the **Format** tab to change the appearance, the position and the numbering of the axis.

Click on the **Number** tab to change the number format used for the numbering. Select the **Default** item to use the default number format of the document (see chapter **The Preferences Dialog** on page 48)

Eventually, click on the **Font** tab to change the appearance of the font used for the numbering.

Modifying the Grid

To modify the appearance of the document grid, chose **Grid** under the **Format** menu.

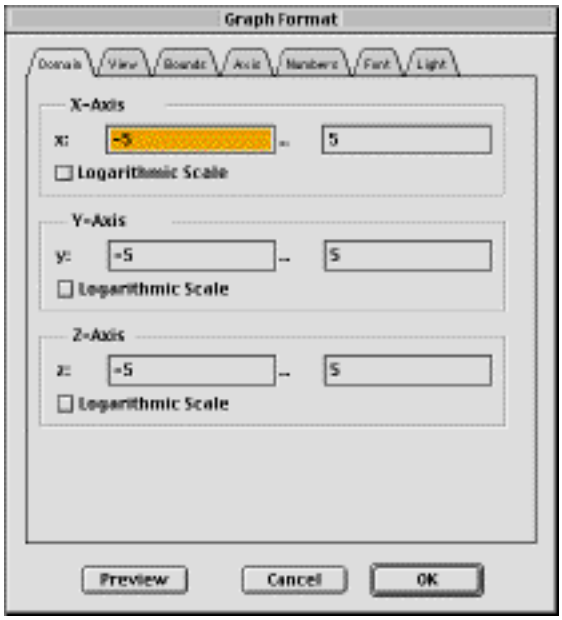
In the appearing dialog, you can select the coordinates type (rectangular or polar), the main and second grid specifications as well as the background color and the document bounds.

♦ Note

To change the document margins, chose **Document** under the **Format** menu and click on the **Margins** tab.

Modifying the Graph Appearance in a 3D Document

To modify the graph appearance, chose **Graph** under the **Format** menu, or double-click on the graph in the document window. Following dialog appears:



Graph Range

Click on the **Domain** tab to change the graph range as well as the different scales.

View

Click on the **View** tab to change:

- The angle of view by entering the rotation values
- The perspective kind
- The three axis ratios. **Proportional** means a width of the graph proportional to its range, as the percentage indicates a fixed width.

Bounds

Click on the **Bounds** tab to select:

- The different colors of the graph faces (x=0, y=0 and z=0 planes)
- The background color
- The three legends.

Axis

Click on the **Axis** to modify:

- The three axis
- The tick-marks and numbering

- The main and second grids.

♦ Note

The tick-mark spacing value is automatically set according the value entered in the **Preferences** dialog (see page 46).

Number and Font

The two tabs **Numbers** and **Font** reveals options to change the format and appearance of the numbering. See page 24 for the details about these options.

Light

Click on the **Light** tab to modify the light source (or the lighting in QuickDraw™ 3D mode).

Numerical Evaluations

In Curvus Pro, you can easily perform numerical evaluations, such:

- Calculating the coordinates of a point from a graph, its various derivatives, tangents and osculating circles, etc.
- Finding* roots, extrema and inflexion points
- Finding the intersection of two cartesian curves
- Integrating the area under a curve, the volume of a graph, etc.

♦ Note

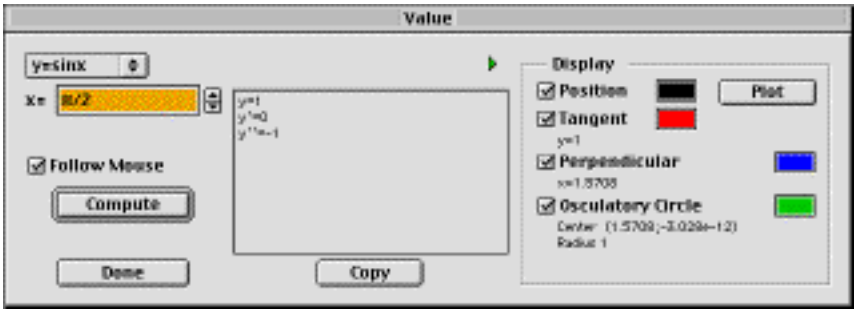
It is possible to enter a expression in any field where a real number is required (e.g. "exp2", "2π", "(1+√5)/2", etc.).

2D Document

Evaluating Values at a Point

To evaluate different values at a point of a curve, select **Evaluation** under the **Options** menu or click on the of the **Options** toolbar.

Following dialog appears:



Select in the top left pop-up menu the desired curve. Fill in the field(s) under it and click on **Calculate**.

It is also possible to move the mouse cursor over the document window if the option **Follow Mouse** is checked.

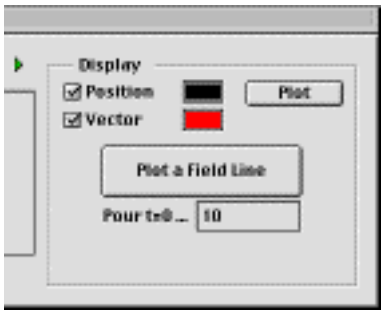
The values of the several coordinates, derivates, etc. appears in the middle box.

In the right-hand part of the dialog (which can be masked or shown by clicking on the little green triangle), it is possible to select the elements to be shown in the document window.

Click on the **Plot** button (or click in the document window at the desired place) to insert the drawn objects into the document.

For vector and scalar fields, the right part of the dialog is a little bit different:

* Only available for cartesian curves in a 2D document.



Click on the **Plot a Field Line** button to insert a field line starting from the calculated point. You can also acheive this by click on the document window with the **Option** key down.

Root Finding*

To find roots, extrema or inflexion points of a curve, chose **Root Find** under the **Options** menu or click on the icon of the **Options** toolbar.

Following dialog appears:

Select in the pop-up menus of the upper part the kind of find to perform, enter a starting value and click on **Find**.

Finding Intersection between Curves

Chose **Intersection Find** under the **Options** menu or click on the icon of the **Options** toolbar. The procedure to follow is the same as the one described above.

Integrating

To calculate the area of the surface under a curve, the length of an arc, the volume of lateral area of a rotation surface, chose **Integration** under the **Options** menu or click on the icon of the **Options** toolbar.

Following dialog appears:

* This option is only available for cartesian curves of type y(x).

Select in the upper part the graph, the kind of integration to perform and the method to be used. Fill in the two integration limits (click on the triangles for infinite limits) and click on **Calculate**.

You can calculate the area between two curves by selecting the checkbox **Difference**.

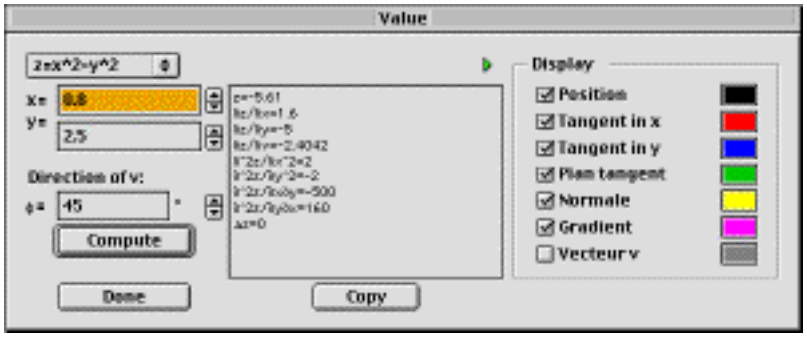
Select the checkbox **Draw Area** if you want the calculated area to be drawn in the document. This latter can be removed by chosing **Remove Integrated Area** under the **Special** menu (the curve must be selected).

3D Document

Evaluating Values at a Point

To evaluate different values at a point of a graph chose **Evaluation** under the **Options** menu or click on the icon of the **Options** toolbar.

Following dialog apears:



Select in the top left pop-up menu the desired graph (surface, field or curve). Fill in the following fields and click on Calculate,

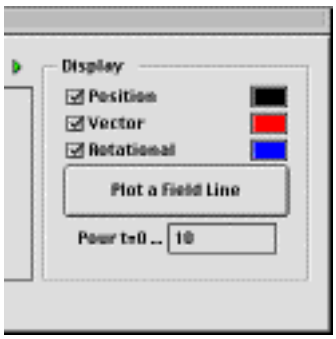
The calculated values (coordinates, derivatives, etc.) are shown in the middle box.

♦ Important

The following options are only available when the QuickDraw™ 3D mode is activated.

In the right-hand part of the dialog (which can be masked or shown by clicking on the little green triangle), it is possible to select the elements to be shown in the document window. You can also spin the graph with the mouse by dragging it in the document window.

For vector or scalar fields, this part is a little bit different:



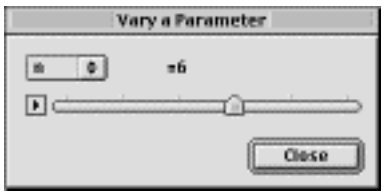
Click on the **Plot a Field Line** button to insert a field line starting from the calculated point.

Dynamic Options

Animations

Varying a Parameter

Once your 2D document contains one or more families of curves (see chapter *** on page ***), you may display only the curves corresponding to one value of a parameter. To do so, chose **Vary a Parameter** under the **Curve** menu. Following dialog appears:

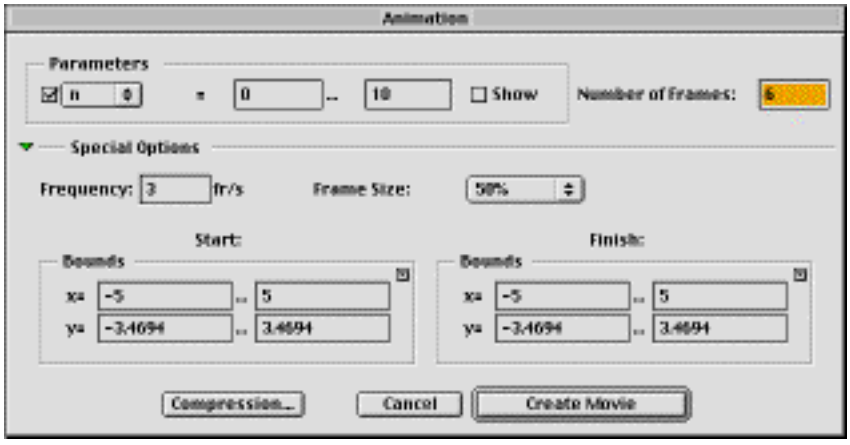


Select the parameter to vary and click on the icon to start the animation or move the cursor to change the value of the parameter.

Creating a QuickTime Movie

In order to visualize the evolution of some curves or graphs as function of certain parameters (or when changing the window range), you can create QuickTime movies with Curvus Pro.

Chose Animation under the Special (in a 2D document) or Options (in a 3D document) menu or click on the icon (or in a 3D document). Following dialog appears:



In the top left part, select the parameter(s) which value is to be varied. For that, chose the desired parameter (or custom constant) in the pop-up menu, check the box next to it and enter the initial and final values. Select the checkbox

Show if you want the parameter value to be shown at the bottom of the animation.

In the other fields, you may enter different animation parameters (frame number, rate, size, compression, etc.).

In the bottom part of the dialog, you can chose the initial and final window range (as well as the view angles in a 3D document).

Confirm the dialog to create the QuickTime movie.

You may also create QuickTime movie from a navigation path. See chapter **Navigation** on page 32 for further information.

Using QuickDraw™ 3D

QuickDraw™ 3D is a system extension providing three dimensional object visualizing and handling. Curvus Pro take advantage of it for real time 3D-graph manipulation.

♦ Note

This extension is not available for 680x0-based machines.

To activate this display mode (of course only available for 3D documents), select Activate QuickDraw™ 3D under the QuickDraw menu. This mode is used exclusively for the graph display so that no vector drawing isn't shown nor can be used.

♦ Important

Be sure that this extension is located in the Extensions folder of your System Folder.

Navigation

Once QuickDraw™ 3D is activated, chose **Navigation** under the **QuickDraw** menu to swap to the navigation mode.

Follow toolbar appears then (click on the green triangle to show or mask the right part):

In this mode, you can move the viewpoint location or *navigate* about (or inside!) the graph.

Moving

There are several ways of moving the viewpoint location:

- By clicking with the mouse at any direction in the document
- By using the **Number Pad keys**
- By using the right part of the toolbar above
- By following a curve (see paragraph **Options** below)

♦ Note

Keep the Shift, Option, Control or Command keys down to change the navigation speed.

Recording the Path

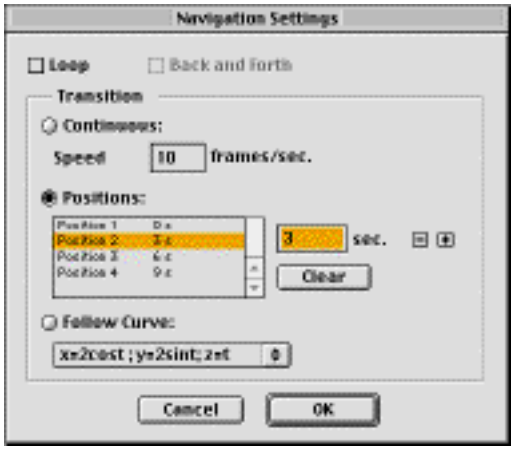
You can record the path you're moving on by clicking on the icon . To pause the recording, click on .

Once a path is recorded, you can follow it again by using the icons , and .

You can also click on the progress bar to jump to the corresponding position.

Options

Click on the icon to make the following dialog appear:



You can chose different playback modes (loop, back and forth) and recording modes (Transition):

- The **Continue** mode record each move.
- The **Positions** mode record each position (each time you click on the icon) and then perform a smooth transition between each, in the order they were recorded
- The **Follow the Curve** mode (only available for parametric curves and differential equation solutions) defines a path follow the selected curve. It cannot be modified.

Creating a QuickTime Movie

Click on the icon to create a QuickTime movie from the recorded path.

Deactivating Navigation Mode

Just click on the close box of the **Navigation** toolbar or chose **Close** under the **File** menu. The recorded path is kept in memory and can saved with the document file.

- Note

  The navigation mode is automatically deactivated when another document is brought to the front.

Advanced Features

Numerical Data

In a 2D document, you can add a curve defined by a set of numerical data corresponding to an array of values. For that, chose **Numerical Data** under the **Special** menu. In the dialog appearing, you can enter a set of points or import it from any text file.

Slide Show

A slide show can be performed from a folder containing several Curvus Pro files. They are displayed in turn during a certain amount of time. Many slide show options are available.

Creating a Slide Show

Create a folder (in the Finder) in which are placed or saved a set of 2D, 3D documents or QuickTime movies.

Slide Show Options

You may define some options for each of these files. To change them, open the file and chose **Slide Show Options** under the **File** menu.

- Important

  Do not forget to save the document after modifying any slide show options.

2D Document

The slide show options for a 2D document can be modified in the following dialog:

You can specify a custom display duration in the top left part. Click on the Image button to add a title picture which is shown under the document during the slide show.

Select the Vary Parameter checkbox to let the value of the selected parameter being varied during the slide show (see chapter **Navigation** on page 32).

3D Document

The slide show options for a 3D document can be modified in the following dialog:

The options of the upper part are the same as the ones for a 2D document. On the other hand, you may chose between three display modes:

- **Normal**: the file is simply opened.
- **Transition**: during the slide show, a transition is performed between to selected viewpoints. These can be defined in the lower part of the dialog. Click on **Define** to change a position according to the current point of view.
- **Navigation**: the recorded navigation path (see chapter **Navigation** on page 32) will be followed during the slide show.

Starting the Slide Show

To start the slide show, chose **Launch Slide Show** under the **File** menu.

In the dialog appearing then, chose the folder containing the files to be shown and confirm it.

During the slide show, you can skip to the next document with the **arrow keys**.

Exporting

PICT File

To export the picture of the current document into a PICT file, chose **Export**, **PICT File** under the **File** menu.

Data Array

To export a data array corresponding to a curve or a graph into a text file chose Export, Data Array under the File menu.

Select the High Precision checkbox to export the values with a maximum number of digits. Otherwise, the current number format is used.

The created file can be then opened by any spreadsheet.

3DMF File

If the QuickDraw™ 3D mode is activated you can export the graph as a 3DMF model by choosing **Export**, **3DMF File** under the **File menu**.

The created file can be read by SimpleText, e.g.

Sound

Curvus Pro provides a sound synthesizer that create sound according to a cartesian curve of type y(x).

Chose **Synthesize Sound** under the **Special** menu. In the dialog appearing, you can change the different parameters. Click on **Play** to play the sound or on **Save** to save it into a file.

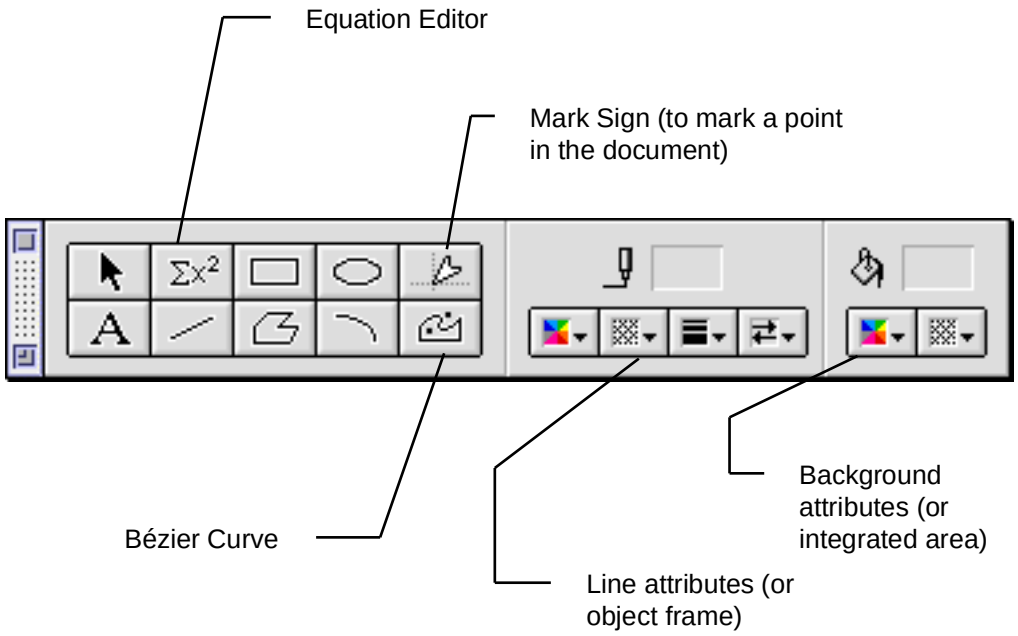
The created sound can be played again just by double-clicking on it in the Finder.

Annexes

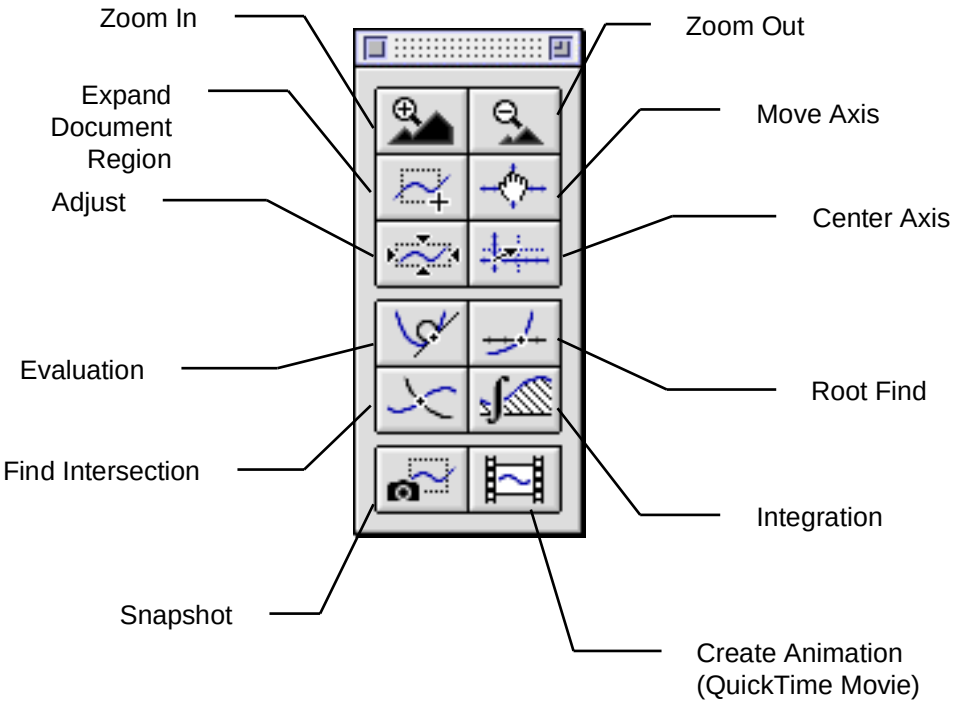
The Toolbars

Each toolbar can be shown or hidden from the corresponding item of the **Window** menu.

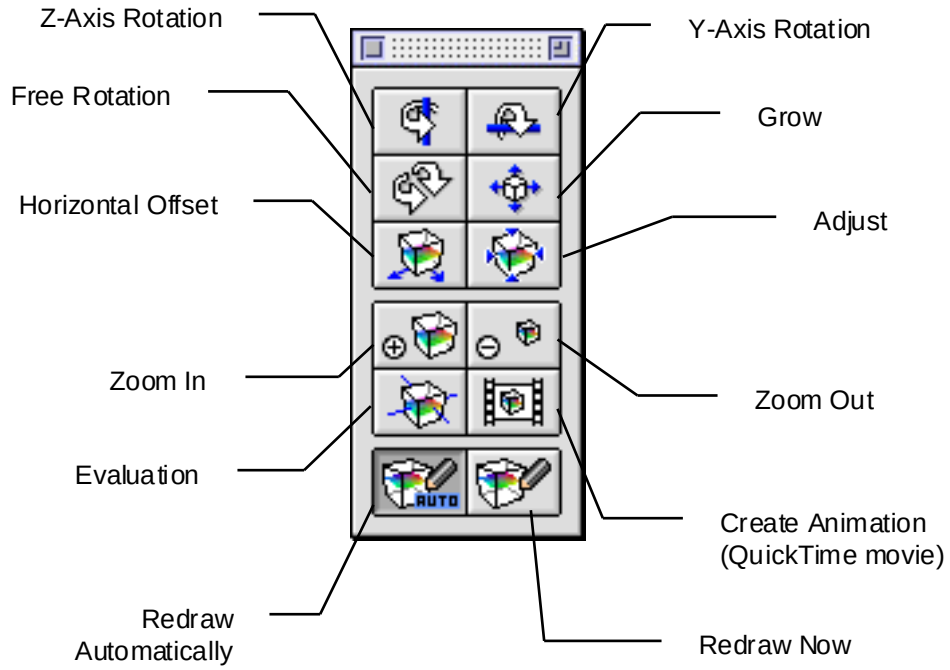
Tools Toolbar


Equation Editor
Mark Sign (to mark a point in the document)
Bézier Curve
Line attributes (or object frame)
Background attributes (or integrated area)

Options Toolbar (2D)



Options Toolbar (3D)



Parameters Toolbar

Definitions of the parameters

- To **create** a new parameter, click on a empty line.
- To **select** a parameter, click once on it.

Comment:

To **select** several parameters, keep the Shift or Command key down.

To **modify** a parameter, double click on it.

Delete the parameters

Click on this icon to delete the selected parameters. If no parameter is selected, all parameters will be deleted.

Save the parameters

Click on this icon to save the parameters in a file.

Load parameters

Click on this icon to load parameters from a file.

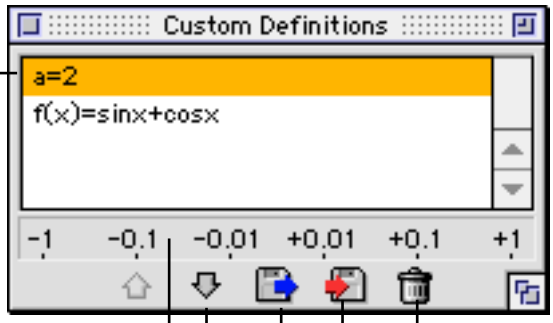
Move a parameter

Click on on arrow to move a parameter in the list in order to have it sorted in the desired order.

♦ Note

See chapter **Variable Parameters** on page 18 for further information about using such parameters.

Custom Definitions Toolbar



Creation of the custom definition

- To **create** a new definition, click on a empty line and type a new expression.
- To **select** a definition, click on it.

Comment:

To select several definitions, keep the Shift key down (or Command key for discontinuous selection).

To **modify** a definition, double-click on it.

To **copy** into the clipboard the expression of the selected definitions, choose Copy in the Edit Menu.

Increment bar

Select a definition (typically a constant), and click on this bar to increment or decrement its value.

Move a definition

Click on on arrow to move a definition in the list in order to have it sorted in the desired order.

Load the definitions

Click on this icon to load definitions from a file.

Save the definitions

Click on this icon to save the definitions in a file.

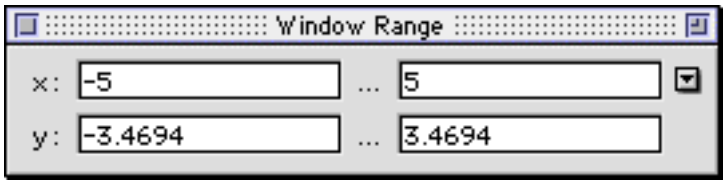
Delete the definitions

Click on this icon to delete the selected definitions. If no definition is selected, all definitions are deleted.

♦ Note

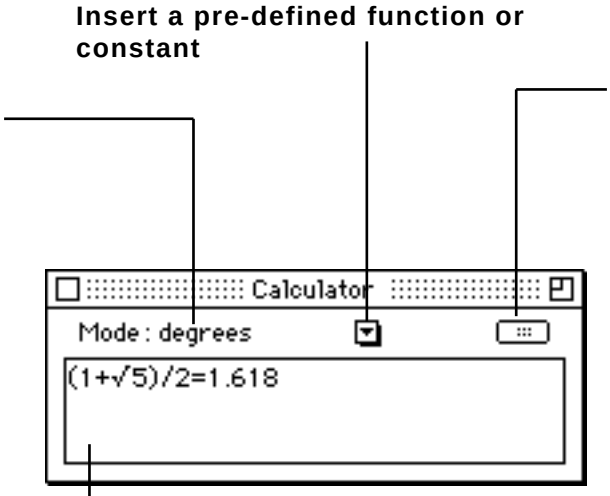
See chapter **Custom Definitions** on page 19 for further information about using such custom definitions.

Window Range Toolbar



Enter the boundary values of the window range. Click on the triangle to restore a recently used range.

Calculator Toolbar



Mode
Choose the mode (degrees, radians, grades) for the trigonometric calculations

Insert a pre-defined function or constant

Confirm
Computes the expression and shows the result. Equivalent to typing Return or “=”

Expression
Click on the zone to select the text, type in the expression you want to evaluate and confirm.
To use the previous result, click once more on the right of the “=” sign and type in the new expression.

- Note

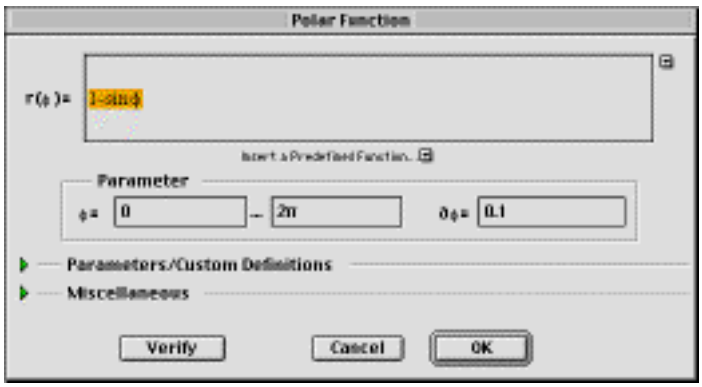
  All calculations are performed with complex numbers (either i or j is recognized for the imaginary part).

Graph Definition Dialogs

Most curve and graph definition dialogs have a similar common structure, which main features are described below.

For some special graphs, the dialog presents some specific options that are described starting from page 45.

When a new curve is created or when an existing curve is modified, a dialog similar to the one below appears:



♦ Note

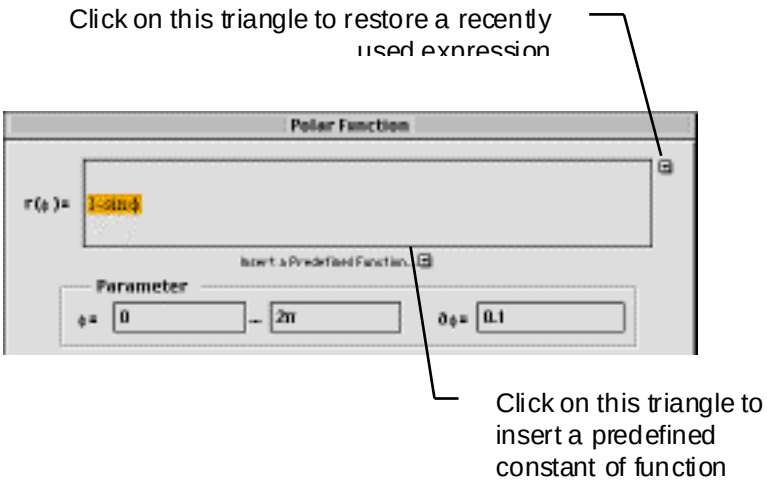
Click on the green triangles to expand the dialog and show further options.

Entering an Expression

In the upper part of the dialog, enter the expression(s) describing the graph. For some graphs, you may also enter the range of the parameter(s).

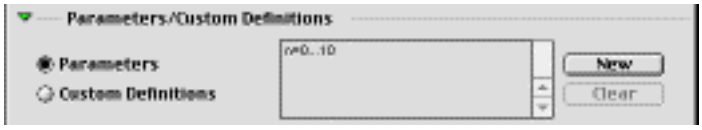
♦ Note

You may enter an expression in any fields that requires a numerical value. For example, you can define a polar curve for φ between "0" and "2π". You may even make reference to a parameter in any of these fields.



Parameters and Custom Definitions

In the middle part, you can create, modify or delete a parameter or a custom definition.

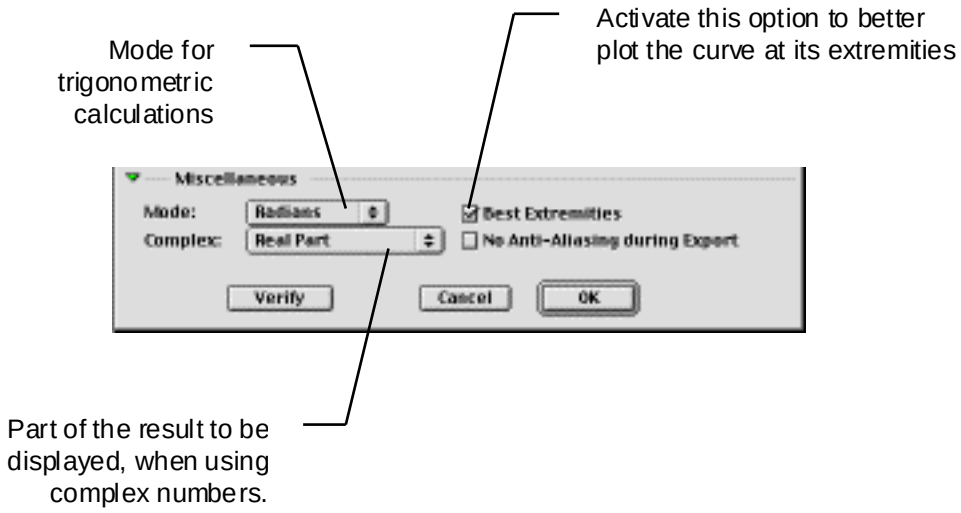


Double-click on a element of the list to modify it.

See chapter **Using Parameters and Custom Definitions** on page 18 for further information.

Miscellaneous Options

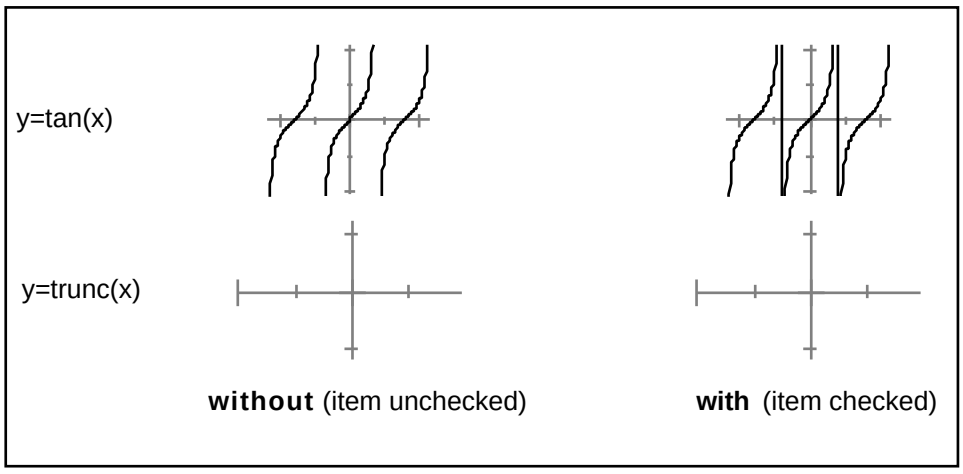
The bottom part of the dialog provides miscellaneous options specific to each kind of graph. Following options are the most frequent:



Specific Options

Cartesian Curves y(x)

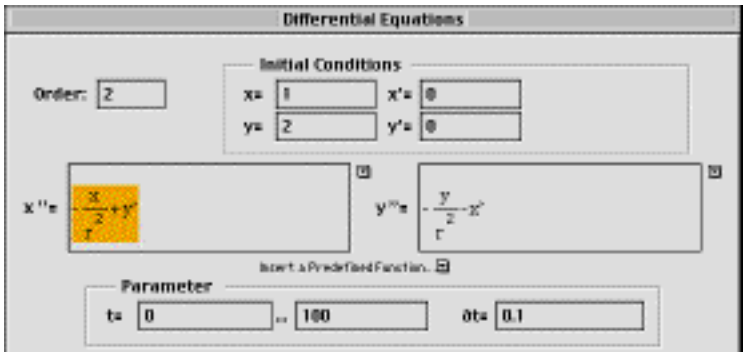
Vertical Asymptote If this option is activated, the curve is plot with a continuous line. Otherwise, vertical segments corresponding to vertical asymptotes or "jumps" are not drawn. See the example below:



Example of plot with and without the option **Vertical Asymptotes**.

Differential Equations

Initial Conditions That are the boundary conditions for the initial time (usually zero).



- Note

  For a system of differential equations of order two or greater, you can use the variables «x'» and «y'» (or «x''» et «y''»), as well as «v» ($=\sqrt{(x'^2+y'^2)}$, the velocity).

The Preferences Dialog

This dialog provides numerous options and is therefore quite large. Nevertheless, the meaning of most options is quite obvious. Only the few that may be confusing are described below.

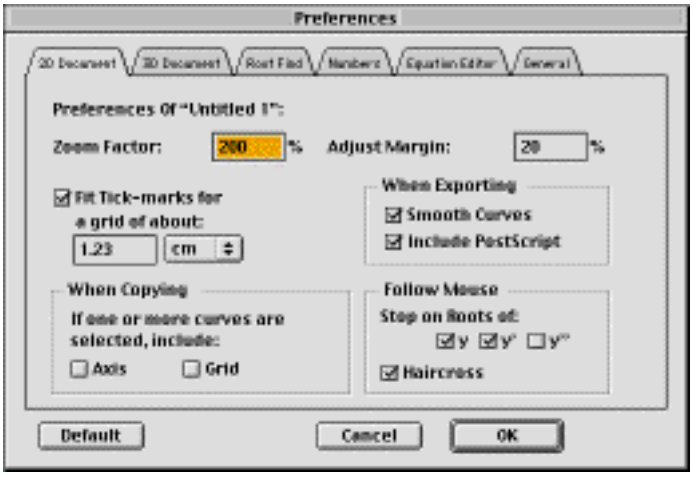
The generic preferences are used when no document is available or if the current document type is not concerned (like the **3D Document** tab for a 2D document). See the first line under the tabs.

♦ Note

Click on the **Default** button to restore the default values for the displayed options.

2D Document

Click on the 2D Document tab to obtain following dialog:



Smooth Curves If this checkbox is selected, the curves are smoothed when they are exported (not in high definition). This will avoid some "steps" to appear when the picture is exported toward another application.

♦ Note

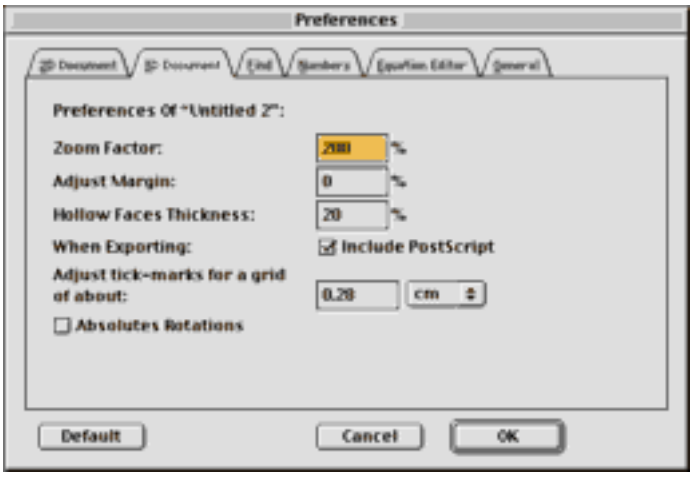
The printing quality will be the best if using a PostScript printer thanks to the PostScript data included to the exported picture.

Follow Mouse When the item Stop on Roots of y is checked, and while moving the mouse cursor over a root of a curve in the document window, the "exact" value of the root will be calculated. A tick sound is then heard. Analogously, when y' is checked, Curvus Pro will round the haircross position to the next extremum of the curve.

Haircross Check this option to activate the haircross appearing when moving the mouse cursor over a curve in the document window.

3D Document

Click on the **3D Document** tab to obtain following dialog:



Automatic Proportions Check this option if you want the proportion ratios to be adjusted automatically according to the types of the graphs contained in the document (see chapter **View** on page 25). For example, a graph containing one cartesian curve z(x,y) will have following ratios:

x and y	100 % (maximum width)
z	proportionnal

Absolute Rotations When this option is checked, rotations are done about the absolute axes instead of the graph axes.

Root Find

Click on the **Root Find** tab to modify the parameters concerning the find of root or intersection (only for 2D document).

Numbers

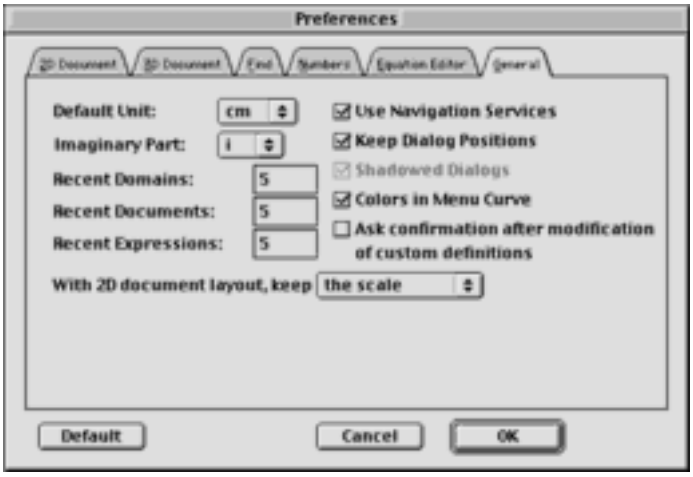
Click on the **Numbers** to change de default number format.

Equation Editor

Click on the **Equation Editor** tab to modify the parameters for the equation editor. You can enable or disable it, select the default font and the key combination for line feeds.

General

Click on the **General** tab to display the follow dialog:



Conclusion

Troubleshooting

Bad Quality Printing

When I export an image toward another application and I print it, the curves show staircase defects

This is a problem that occurs in the majority of applications. This happens because, before being printed, all images are converted to 72 dpi*, leading to a loss of quality for high definition images.

Look at the examples shown at right (these are enlargements):

- The first curve was printed directly in Curvus Pro, without any defects.
- The middle one has been exported to another application. The very annoying staircases show up in the printout, even if the curve has been exported with high definition.
- The last one has been exported with the smoothing option and the printed in another application. Even so very slight imperfections persist (because the printout is done with 72 dpi and not in 360 dpi like in Curvus Pro), the quality is much better than before.

Printed in Curvus Pro

Exported toward another application

Exported with the smoothing option

To solve this problem, be sure that the option **Smooth Curves** in the **Preferences** dialog (see page 47) is activated (normally on), then copy the image normally (without keeping the **Option** key down). You will get the best quality in your printouts.

♦ Important

Avoid reducing the size of an image containing curves after exporting. It is better to reduce the size of the original document before exporting the image.

* dpi = *dots per inch*

The curve doesn’t show up

- The curve overruns the selected domain of representation. Choose the item **Adjust** under the **Special** menu.
- The curve is not defined, this means that the equation returns an undefined number (for ex. dividing by zero, log(x) for x<0). To check this, choose the item **Value** under the menu **Options**, and check a few points. You should see that the result is “undefined”.

Contacting & Updating

Don't hesitate to give us part of your opinions, comments or questions! This is the way we improve our product! Bug reports are also welcome.

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Internet

The latest version of Curvus Pro is always downloadable at the following address, as well as several tutorial files, etc.

http://www.curvuspro.ch